

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
6 January 2005 (06.01.2005)

PCT

(10) International Publication Number  
**WO 2005/002302 A1**

(51) International Patent Classification<sup>7</sup>: **H05K 1/02, 7/20**

(21) International Application Number:  
PCT/GB2004/002452

(22) International Filing Date: 10 June 2004 (10.06.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
0314637.0 24 June 2003 (24.06.2003) GB  
03253983.5 24 June 2003 (24.06.2003) EP

(71) Applicant (for all designated States except US): BAE  
SYSTEMS PLC [GB/GB]; 6 Carlton Gardens, London  
SW1Y 5AD (GB).

(72) Inventor; and

(75) Inventor/Applicant (for US only): WESTBURY, Steven,  
Dale [GB/GB]; Bae Systems Avionics Limited, Cliftonford  
Road, Southway, Plymouth, Devon PL6 6DE (GB).

(74) Agent: BAE SYSTEMS PLC; Intellectual Property  
Department, PO Box 87, Lancaster House, Farnborough  
Aerospace Centre, Farnborough, Hampshire GU14 6YU  
(GB).

(81) Designated States (unless otherwise indicated, for every  
kind of national protection available): AE, AG, AL, AM,  
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,  
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,  
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,  
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,  
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,  
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,  
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,  
ZW.

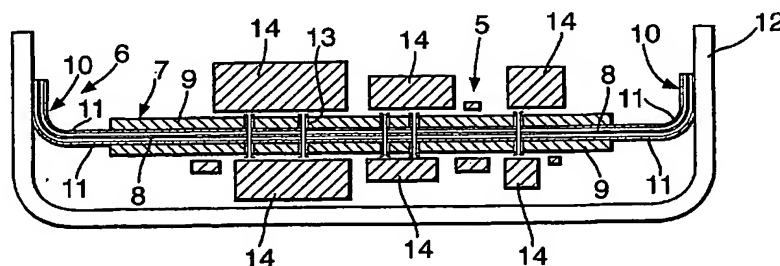
(84) Designated States (unless otherwise indicated, for every  
kind of regional protection available): ARIPO (BW, GH,  
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,  
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,  
FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI,  
SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: FLEXI-RIGID PRINTED CIRCUIT BOARD WITH INTEGRAL FLEXIBLE HEAT SINK AREA



(57) Abstract: A flexi-rigid printed circuit board (5) has a rigid area (7) made up of inner layers (8) of flexible copper and outer layers (9) of rigid insulating material. The board (5) includes an integral flexible heat sink area having springy edge regions (10) of exposed flexible copper layers without outer layers (9) of rigid insulating material, and a metal heat conducting body (12) which is springily engaged for the rigid areas (7) of the board (5).

- 1 -

## **FLEXI-RIGID PRINTED CIRCUIT BOARD WITH INTEGRAL FLEXIBLE HEAT SINK AREA**

This invention relates to a flexi-rigid printed circuit board with integral flexible heat sink area.

5           Conventionally heat is conducted away from key electronic components in a confined area of a printed circuit board by using a soft thermal interface material 1 sandwiched between the electronic components 2 and an aluminium heat spreader 3 as shown in Figure 1 of the accompanying drawings. The soft thermal interface material 1 is used to conform to the electronic component  
10 skyline and transfer heat to the aluminium heat spreader 3 from which this heat is then transferred to the external body components 4 of the assembly. This conventional assembly is not cost effective as it requires additional components such as the interface material 1 and aluminium heat spreader 3 which additionally add weight and space requirement to the assembly as well as cost.

15           *There is thus a need for a simpler and more cost effective system for conducting heat away from key electronic components on a printed circuit board in a confined area.*

          According to a first aspect of the present invention there is provided a flexi-rigid printed circuit board having a rigid area, made up of inner layers of  
20 flexible copper and outer layers of rigid insulating material, and an integral flexible heat sink area having springy edge regions of exposed flexible copper layers without outer layers of rigid insulating material, and a metal heat conducting body which is springily engaged by the edge regions to provide a heat sink for the rigid areas of the board.

25           Preferably the exposed flexible copper layers of the springy edge regions are at least partially coated with an anticorrosive material, more preferably at least one of tin, lead, gold.

          Conveniently the board includes tubular metal thermal vias interconnecting flexible copper layers in the rigid area to improve heat transfer  
30 through the flexible copper layers.

- 2 -

Advantageously at least some of the thermal vias are located in the rigid area below parts where high heat output components are to be mounted.

Preferably the metal heat conduction body is a shell into which the heat sink area is a push fit and held in place by spring contact between the springy  
5 edge regions and the shell.

Conveniently the springy edge regions are in the form of tabs extending from the rigid area.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made to the  
10 accompanying drawings, in which;

Figure 1 is a perspective exploded view of a conventional printed circuit board assembly with a heat conduction system not according to the present invention,

Figure 2 is a diagrammatic perspective view of a flexible heat sink area  
15 with heat conducting body according to the present invention,

Figure 3 is a perspective view of part of a flexi-rigid printed circuit board according to the present invention,

Figure 4 is a cross-sectional view of an assembled flexi-rigid printed circuit board according to the present invention taken through an assembled  
20 flexi-rigid printed circuit board along the line A-A of Figure 5, and

Figure 5 is a perspective exploded view of a flexi-rigid printed circuit board according to the present invention forming part of an assembly.

A flexi-rigid printed circuit board 5 with integral flexible heat sink indicated generally at 6 according to the present invention is shown in Figures 2 to 5 of  
25 the accompanying drawings. The flexi-rigid printed circuit board 5 has at least one rigid area 7 made up of inner layers 8 of flexible copper as can best be seen from Figure 4 and outer layers 9 of rigid insulating material. The board 5 includes an integral flexible heat sink area having springy edge regions 10 of exposed flexible copper layers 11 without the outer layers 9 of rigid insulating  
30 material.

- 3 -

Also forming part of the integral flexible heat sink area is a metal heat conducting body 12 preferably in the form of a shell as illustrated in Figures 4 and 5. As can be seen specifically from Figure 4 the body 12 is springily engaged by the edge regions 10 to provide a heat sink for the rigid areas 7 of the printed circuit board 5. As can be seen more clearly from Figure 4, the heat sink area 7 is a push fit into the shell 12 and is held in place by spring contact between the springy edge regions 10 and the inner wall of the body 12.

Preferably the springy edge regions 10, as can be seen from the three stage drawing of Figure 2, are in the form of tabs extending from the rigid area 7. These tabs can be bent upwardly out of the plane of the rigid area 7 as can be seen on the top right hand of Figure 2 and eventually are butted together as shown in the bottom right portion of Figure 2 to provide effectively a circular form as shown in cross-section in Figure 4. It is to be understood, however, that although the rigid area 7 has been illustrated as basically circular in plan with the springy edge regions 10 extending radially as tabs therefrom and with the body 12 having a tubular format, any other shape of rigid area 7, springy edge regions 10 and body 12 desired can be provided and utilised.

The springy edge regions 10 which effectively form extensions to the rigid area 7 are in the form of the exposed copper layers which extend integrally and as part of the inner layers 8 of flexible copper within the rigid area 7. Preferably the exposed layers of flexible copper which form the springy edge regions 10 are at least partially coated with anti corrosion material such as tin, lead and/or gold, for conductivity and corrosion resistance purposes. Thus the heat conducting layer provided by the inner layers of heat flexible copper runs into the rigid area 7 wherever it can and as many layers as possible are joined with thermal vias 13 as shown in Figure 4. These thermal vias are conveniently tubular metal thermal vias which interconnect the flexible copper layers 8 in the rigid area 7 to improve heat transfer between the flexible copper layers. At least some of the thermal vias 13, as shown in Figure 4, are located in the rigid area 7 below parts where high heat output components 14 are to be mounted.

The invention thus requires fewer components than the conventional solution described in respect of Figure 1, requires no additional assembly time

- 4 -

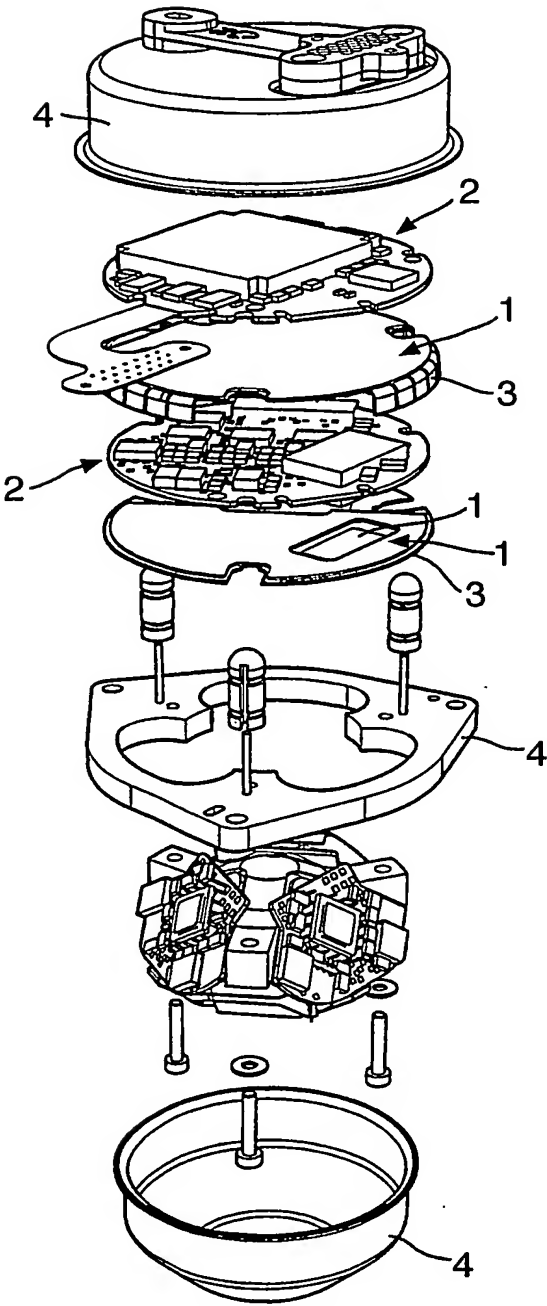
and has minimal extra space requirements as the flexible heat sink is very thin. This can be seen by a comparison between the conventional Figure 1 assembly and the assembly of Figure 5 which incorporates a flexi-rigid printed circuit board according to the present invention. In the illustration of Figure 5 the rigid  
5 area 7 of the flexi-rigid printed circuit board has been shown without electrical components 15 for convenience. The electrical components 15 are nested together and secured to the rigid area 7 and springy edge regions 10 by means of a mounting plate 16 and connecting strap 17. A further casing cover 18 is  
provided for the assembly to cover the components 15.

- 5 -

**CLAIMS**

1. A flexi-rigid printed circuit board having a rigid area, made up of inner layers of flexible copper and outer layers of rigid insulating material, and an integral flexible heat sink area having springy edge regions of exposed flexible copper layers without outer layers of rigid insulating material, and a metal heat conducting body which is springily engaged by the edge regions to provide a heat sink for the rigid areas of the board.
2. A flexi-rigid printed circuit board according to Claim 1, wherein the exposed flexible copper layers of the springy edge regions are at least partially coated with an anti corrosion material.
3. A flexi-rigid circuit board according to claim 2, wherein the anti corrosion material is at least one of tin, lead, gold.
4. A flexi-rigid printed circuit board according to anyone of Claims 1 to 3, including tubular metal thermal vias inter-connecting flexible copper layers in the rigid area to improve heat transfer between the flexible copper layers.
5. A flexi-rigid printed circuit board according to Claim 4, in which at least some of the thermal vias are located in the rigid area below parts where high heat output components are to be mounted.
6. A flexi-rigid printed circuit board according to any one of Claims 1 to 5, wherein the metal heat conducting body is a shell into which the heat sink area is a push fit and held in place by spring contact between the springy edge regions and the shell.
7. A flexi-rigid printed circuit board according to any one of Claims 1 to 6, wherein the springy edge regions are in the form of tabs extending from the rigid area.
8. A flexi-rigid printed circuit board substantially as hereinbefore described and as illustrated in any one of Figures 2 to 5 of the accompanying drawings.

Fig.1.



2/3

Fig.2.

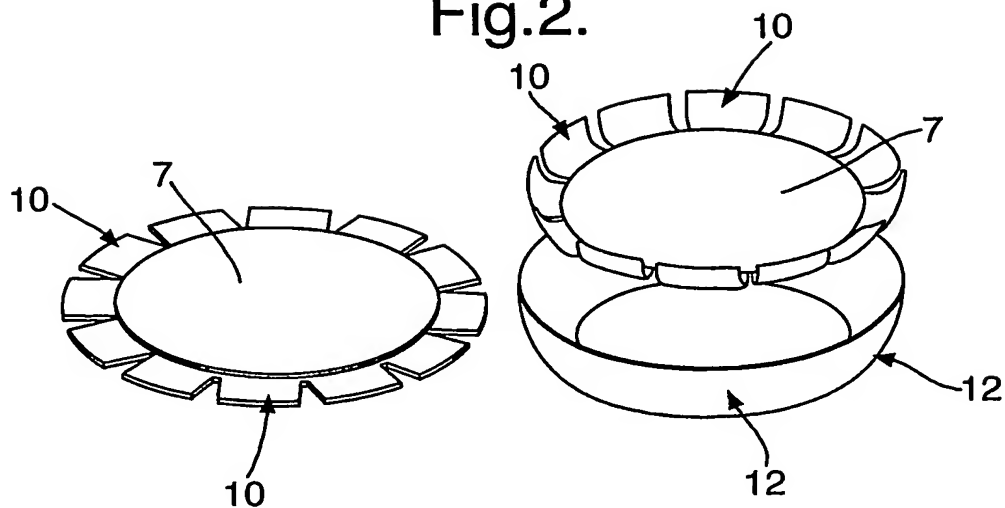


Fig.3.

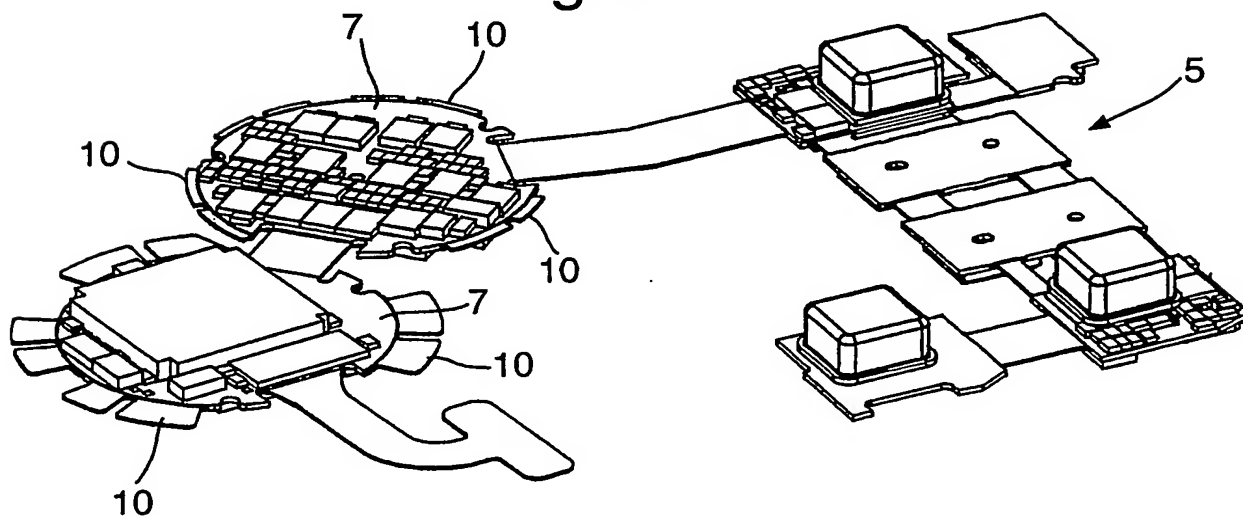
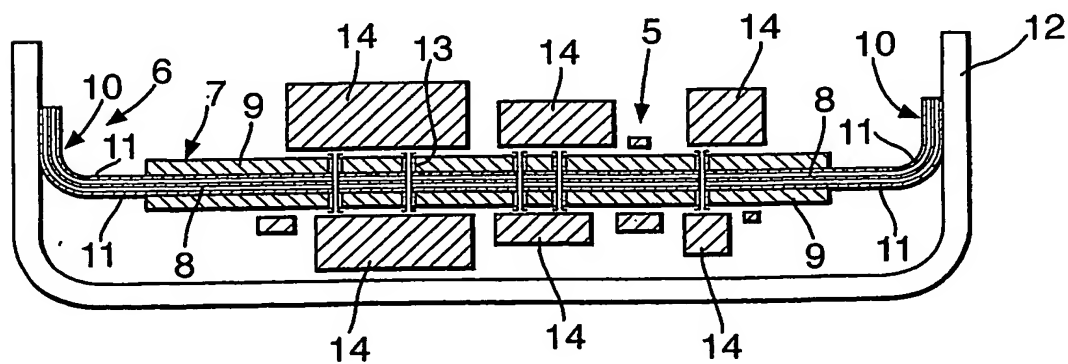


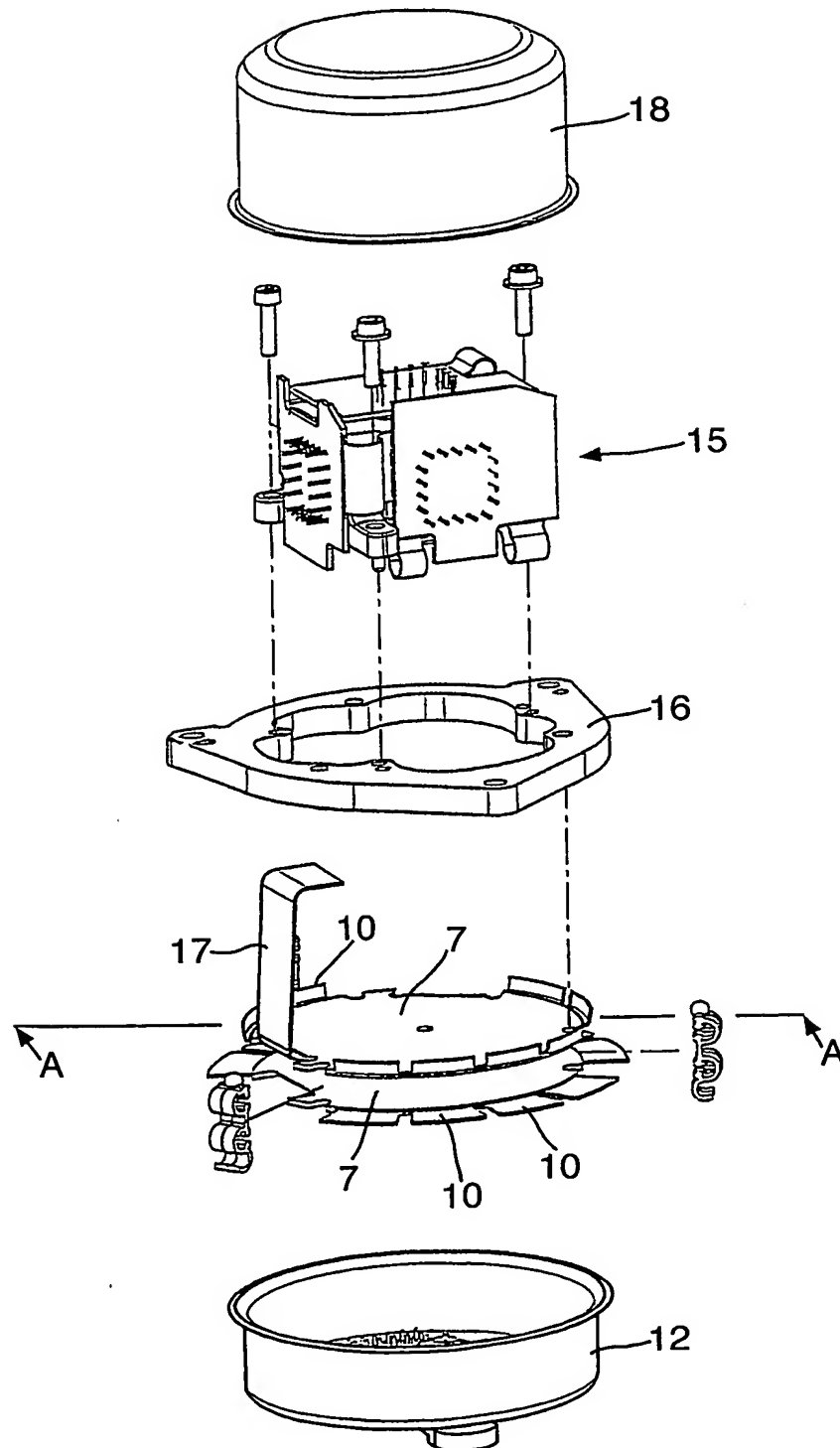
Fig.4.





3/3

Fig.5.



A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H05K1/02 H05K7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 212 076 B1 (MACQUARRIE ET AL.) 3 April 2001 (2001-04-03) column 5, line 28 - line 34 column 6, line 3 - line 35; figure 8	1-4
A	GB 2 124 035 A (STANDARD TELEPHONES AND CABLES LTD) 8 February 1984 (1984-02-08) claims; figures	1, 4
A	US 4 949 225 A (SAGISAKA ET AL.) 14 August 1990 (1990-08-14) figure 10; example 6	1, 4
A	US 4 149 219 A (KRAFT) 10 April 1979 (1979-04-10) the whole document	1, 7
	----- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*G\* document member of the same patent family

Date of the actual completion of the international search

2 September 2004

Date of mailing of the international search report

15/09/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3016

Authorized officer

Batev, P

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 497 495 A (ISHIKAWA ET AL.) 5 March 1996 (1996-03-05) column 5, line 22 - line 28; figure 5 -----	1
A	US 6 118 072 A (SCOTT) 12 September 2000 (2000-09-12) claims; figures -----	6,7
A	US 4 725 920 A (IJICHI ET AL.) 16 February 1988 (1988-02-16) column 3, line 18 - line 23; figure 2 -----	6,7

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

1/GB2004/002452

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6212076	B1	03-04-2001	NONE
GB 2124035	A	08-02-1984	NONE
US 4949225	A	14-08-1990	JP 1199497 A 10-08-1989 JP 1862297 C 08-08-1994 JP 5070316 B 04-10-1993 US 5099395 A 24-03-1992
US 4149219	A	10-04-1979	NONE
US 5497495	A	05-03-1996	JP 3231349 B2 19-11-2001 JP 4332013 A 19-11-1992
US 6118072	A	12-09-2000	NONE
US 4725920	A	16-02-1988	JP 61066993 U 08-05-1986 DE 3535923 A1 10-04-1986 GB 2165399 A ,B 09-04-1986 KR 8907939 Y1 10-11-1989